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浙江江山白垩系一新的蜥脚类恐龙[1)]

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摘要　记述的巨龙科 Titanosauridae 一新属种——礼贤江山龙(*Jiangshanosaurus lixianensis* gen. et sp. nov.)产自浙江江山的金华组下部,地质时代为早白垩世晚期的 Albian 期。化石保存了部分头后骨骼,经过与晚侏罗世至晚白垩世蜥脚类化石的对比表明,新属的尾椎特征与巨龙科较为相似,肩胛骨、乌喙骨与巨龙科中的阿拉蒙龙属(*Alamosaurus*)最为接近,但新属的前部尾椎较大,前凹后突的程度较不明显。新属种保存的背椎和中部尾椎的部分特征与我国晚侏罗世马门溪龙科也很相近。

新属种是在我国首次记述的巨龙科化石,为研究白垩纪蜥脚类恐龙在我国的演化分布提供了新的材料。

关键词　浙江江山,早白垩世,巨龙科,江山龙属

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1977～1978 年,浙江省江山县礼贤公社陈塘边发现了大型恐龙的脊椎化石,浙江省博物馆即先后派魏丰、吴维棠和康熙民等前往现场,采集了属于同一恐龙个体的背椎 5 节、尾椎 3 节、左肩胛骨、乌喙骨和部分左股骨、耻坐骨及若干肋骨等。化石产出层位为金华组下部的含砾细砂岩,同位素年龄值由江西省区域地质调查队测定为 105Ma(Rb-Sr 等时线法)[2)],应为早白垩世晚期的 Albian 期。在浙江与此层位相当的还有中戴组(方岩组二段)和塘上组,其中曾分别产出过兽脚类恐龙 *Chilantaisaurus zhejiangensis* 和翼龙 *Zhejiangopteris linhaiensis*(董枝明,1979;浙江省地质矿产局,1996),但蜥脚类恐龙还是首次发现。截至今日,这些化石仍是在浙江省发现的最大、最完整的蜥脚类恐龙化石,对研究我国白垩纪蜥脚类恐龙的演化及分布具有重要的意义。

1　化石记述

蜥臀目　Saurischia Seeley, 1888

蜥脚形亚目　Sauropodomorpha Huene, 1932

蜥脚次亚目　Sauropoda Marsh, 1878

巨龙科　Titanosauridae Lydekker, 1885

江山龙属(新属)　Jiangshanosaurus **gen. nov.**

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2) 化石层位资料由吴维棠收集。

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特征　同属型种。

属型种　礼贤江山龙(新属新种) *Jiangshanosaurus lixianensis* gen. et sp. nov.。

词源　属种名称中的"Jiangshan"、"Lixian"分别表示化石产地的县名和乡名,"saurus"源自希腊文,意指恐龙。

正型标本　部分头后骨骼,包括保存较为完好的左侧肩胛骨和乌喙骨,5 个中后部背椎,部分左、右侧耻骨和坐骨,3 个尾椎,及股骨的骨干部分。浙江自然博物馆标本编号:M1322。

产地与层位　浙江省江山县礼贤乡陈塘边早白垩世晚期金华组下部。

特征　背椎神经弓上坑凹、棱板构造发育,棱板边缘较薄。背椎前突较为发育,呈半球状,椎体腹面凹进明显。背肋宽扁,中央具较为明显的凹腔。肩胛骨的肩峰较为宽阔,前后的宽度约为肩胛骨骨干最小宽度的 150 %。肩胛骨的肩臼面略向内侧倾斜,而乌喙骨的肩臼面向外侧倾斜。肩臼开口约呈直角。大而平坦的上乌喙凹略呈卵圆形。乌喙孔位置近于乌喙骨的中央,距与肩胛骨的接合缝较远。最前部的尾椎为前凹型椎体,神经弓着生于椎体的前部,保存的中部尾椎略呈前凹型,椎体侧凹不发育。

描述　左肩胛骨保存较为完整,仅远端缺损,近端与乌喙骨关联保存。肩胛骨保存长度约为 87cm。其中骨干部分保存长 46cm,中部宽约 18cm;近端扩展显著,保存宽度 62cm 左右,与乌喙骨关联部分长约 32cm。骨干最厚处在中轴线偏后缘部分,后缘较为钝圆,前缘变薄呈刃状。近端扩展部分在肩臼及上乌喙凹边缘的隆脊处明显增厚。上乌喙凹较大而平坦,呈卵圆形。与乌喙骨共同组成的肩臼开口较大,长近 30cm,肩胛骨在肩臼的开口面向内侧倾斜。肩峰与骨干过渡平缓并以钝角相交,前缘与乌喙骨前缘大体平齐(图 1A,图版 Ⅰ,1)。

保存的左乌喙骨较大,长 33cm,宽 46cm,呈扁平的卵圆状。乌喙骨面积与肩胛骨近

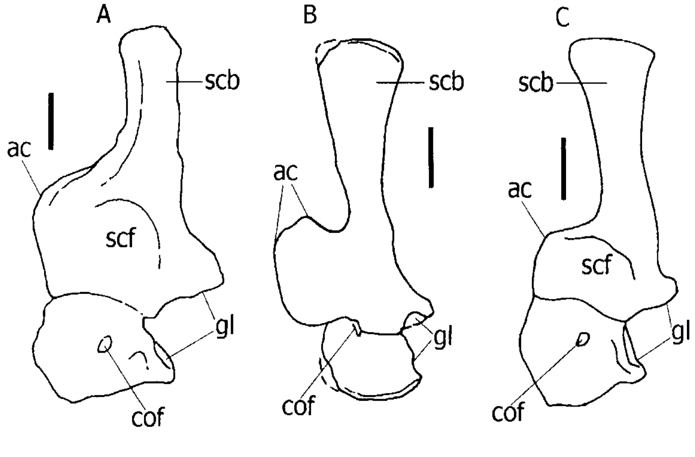

图 1　江山龙(A)、盘足龙(B)和阿拉蒙龙(C)的肩胛骨及乌喙骨的对比

Fig. 1　Left scapulocoracoid of *Jiangshanosaurus* (A), *Euhelopus* (B) in medial view and *Alamosaurus* (C) in lateral view

(B,C modified from McIntosh [1990]), Scale bar equals 30cm

ac, acromion 肩峰; cof, coracoid foramen 乌喙孔; gl, glenoid 肩臼; scb, scapula blade 肩胛骨骨干; scf, supracoracoideus fossa 上乌喙凹

端的上乌喙凹大小相当。乌喙孔较小,几乎位于乌喙骨中央,离肩胛骨的接缝处较远,呈椭圆形,长轴长度为 4.8cm,短轴长 3.6cm。乌喙骨在肩臼处增厚并呈喙状翘起,长度约为 16cm,开口面向外侧略微倾斜,较为粗糙多皱(图 1A,图版 Ⅰ,1)。

耻骨为扁平板状,远端唇状增厚,向内弯曲。左耻骨保存长度约 76cm,远端宽度约为 33cm;右耻骨保存长度为 68cm,远端宽度为 31cm。左、右耻骨联合面粗糙多皱、内翻成唇状,延展宽度约为 5～7cm(图 2A,图版 Ⅰ,2～5)。

坐骨扁平,前缘较薄,后缘略钝圆。保存的左、右坐骨均有缺损,远端较为完整,扩展的近端部分缺损。左坐骨保存长度为 71cm,远端宽约 14cm,骨干中部最小宽度为 11cm,近端向后缘扩展的部分缺失,复原后近端的宽度可能为 32cm,与耻骨的接合面较为钝圆粗厚。左、右坐骨的联合面也比较粗糙多皱,粗糙面延展宽度约 4～6cm。右坐骨保存长度为 52cm,远端宽度为 16cm,骨干最小宽度为 12.6cm,近端后缘扩展不甚明显,与骨干的过渡较为圆缓(图 2B,图版 Ⅰ,6～7)。

股骨保存了部分骨干,保存长度为 84cm,最小宽度为 25cm。应为股骨中段。骨干横断面为扁椭圆形。前视未见第四转子,无法判断其在骨干上的出现位置。

江山龙仅保存 5 个中后部背椎,其中 3 个关节在一起,椎体完整,但椎弓均破碎残损,保存不全。3 个关节的背椎前后关节突关节紧密,大致位于椎弓的中部。椎弓位于椎体的前上部。副突位置较高,与前关节突高度大致平齐。横突较短,斜向上伸,比后关节突位置略高。神经棘较高,顶端略膨大平坦,未见分叉。椎弓保存的棱板及坑凹构造比较发达,但因挤压破碎原始的形态已不甚清晰。椎体较粗壮,高度约占椎弓高度的 3/5;前突明显,呈半球状;椎体的侧凹非常发育,大而深,呈卵圆状,位于椎体前端偏上的位置,侧凹长轴长 5.5～7.8cm。Wilson 和 Sereno (1998) 曾推断,*Omeisaurus* 及比其更为进步的蜥脚类具有 12 个或更少的背椎。根据测量对比,推测这 3 个关节的背椎可能为第 9、10、11 背椎(图版 Ⅱ,9～11)。

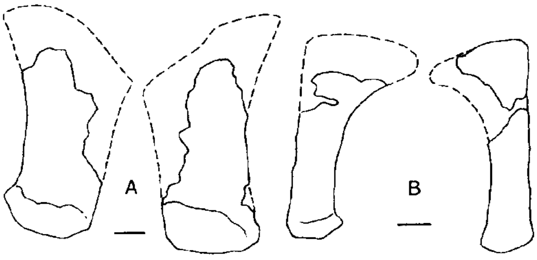

图 2 江山龙的坐骨(A)、耻骨(B)轮廓

Fig. 2 Sketch of pubis(A) and ischium(B) of *Jiangshanosaurus*

表 1 江山龙保存背椎椎体的测量对比

Table 1 Measurements of the dorsal centra of *Jiangshanosaurus* (cm)

	推测序数 Ordinal	椎体长* Length	椎体后高 Caudal height	椎体后宽 Width	侧凹长 Pleurocoel Length	中部凹高 Ventral depth	后突长 Length of process
背椎 D.V.	6	19.5	25	14	8.5	6	5
	7	19	20	15	8.5	5.5	5.5
	9	18	20	—	5.5	3.2	5.0
	10	18	24	—	7.8	3.7	—
	11	18.5	26	—	6.5	5.5	—

*不包括椎体后突长度(except the length of caudal process of centrum)。

此外还保存了 3 个不完整的尾椎。其中一个椎体短而粗壮,呈微弱的前凹型,椎体后突较为明显,但椎体后端的中央略平展;前视椎体宽约 22. 7cm,底视厚约 11. 6cm,依据大小推测可能为第一尾椎;椎弓保存不好,两侧的尾肋近端保存,向椎体上部扩展,略呈耳状,应与椎弓相连接;椎弓应位于椎体的前上方,椎体腹面未见脉弧面(图版 II,1～3)。另两个尾椎大小、形态相似,可能为中部尾椎。其一的神经棘保存较为完整,呈侧扁的棒状,末端略膨大;侧视宽约 5. 8cm,高约 17. 5cm,是椎体高度的 1. 4 倍;后倾的角度较大,和椎体中轴方向约呈 65°角;前关节突很发育,延展宽度与棘宽相当,后关节突的上缘延伸接近椎弓的中部,后缘略与椎体后端的平面平齐;尾肋已消失,仅在椎体两侧偏上端发育尾椎侧突;椎体坚实,前凹型,但后突不强烈;椎体侧视长约 10cm,高约 12cm,椎体前宽约为 9cm,椎体上缘神经孔的直径约为 1. 7cm。另一尾椎的椎弓保存不完整,椎体与上述尾椎的大小相似,但椎体的前凹后突不明显;椎体两侧也未见侧突,仅在上侧缘残存一棱脊,可能为侧突遗留的痕迹。合川马门溪龙自第 15 尾椎以后椎体的前凹型性质逐渐减弱而接近双平型,前部尾椎发育的侧突向后逐渐减小,到第 16 尾椎时完全消失(杨钟健、赵喜进,1972),而在峨嵋龙第 15 尾椎以后,椎体两侧出现一条前后延长的棱脊,直至第 31 尾椎向后,此棱脊方消失未见(何信禄等,1988)。依据这两枚尾椎的形态特征及其对比,推测前者可能为第 13 或 14 尾椎,后者可能为第 16 或 17 尾椎。此外,上述 3 枚尾椎的椎体两侧均未见侧凹发育。

2　对比及讨论

迄今为止,在中国境内报道的早白垩世蜥脚类化石很少,保存均不完整,种类也较单调。1973 年董枝明曾依据一枚完整的勺形齿和一个较完整的背椎,确定在我国新疆乌尔禾江木河口下白垩统的吐谷鲁群中产出蒙古亚洲龙(相似种)(*Asiatosaurus* cf. *A. mongoliensis* Dong,1973);1975 年侯连海等将产于广西扶绥山峪那派村下白垩统那派组的蜥脚类牙齿、颈椎、颈肋和背肋化石鉴定为广西亚洲龙(*Asiatosaurus kwangshiensis* Hou et al. ,1975);1991 年董枝明等研究了产于内蒙古二连浩特东南 65km 处的下白垩统查干诺尔组中的蜥脚类化石,包括一段股骨、两枚牙齿及较为破碎的肠骨、肩胛骨、颈椎和尾椎,定名为查干诺尔龙(*Nuoersaurus chaganensis* Dong,1992)。

蒙古亚洲龙最早由 Osborn 于 1924 年命名,依据的材料是产自蒙古吴启盆地两枚齿冠基本对称、勺凹较浅的勺型齿,我国新疆乌尔禾产出的蒙古亚洲龙(相似种)牙齿化石形态与其近似。本文记述的在浙江江山下白垩统金华组下部产出的蜥脚类恐龙——江山龙,未发现牙齿化石,所保存的背椎与乌尔禾的材料相比差异较大:后者的椎弓部分较为粗壮,前后关节突的位置也较高,神经棘更为高大,但椎弓的坑凹构造较不发育。由于乌尔禾的材料与山东晚侏罗世的盘足龙(*Euhelopus*)比较近似,董枝明(1973)建议将亚洲龙归于盘足龙类。

内蒙古的查干诺尔龙虽然有江山材料保存的肩胛骨和尾椎部分,但均很破碎,很难做深入的比较。

根据目前的记录,国外下白垩统产出的大型蜥脚类化石主要有梁龙类(Diplodocoidea)、腕龙类(Brachiosaurids)和巨龙类(Titanosaurids)(Salgado et al. ,1997)。

其中的梁龙类和巨龙类与江山龙有较多的相似。

梁龙类的前部背椎神经棘分叉,后部背椎椎体未见明显的半球状前突,前部尾椎呈轻度的前凹型,尾脉弧分叉,背椎和前部尾椎的神经棘较高,尾椎侧凹和腹凹发育(McIntosh,1990;Calvo and Salgado,1995);巨龙类颈椎较短,肩带粗大,第一尾椎椎体两端突出,其余为明显的前凹型,尾椎椎弓位于椎体的前上部,背椎神经棘较低(Salgado et al.,1997;McIntosh,1990;Upchurch,1998)。

江山龙的中后部背椎形态兼有梁龙类和巨龙类的特征。比如,椎弓的坑凹、棱板构造都比较发育,椎体前突成半球状,侧凹发达。但与江山龙相比,梁龙类的椎体较短,神经棘相对较高,椎体前突的发育程度也较弱;而巨龙类的背椎椎体上缘与前关节突接近的位置未见副突发育。此外,江山龙保存的背肋具有较为明显的凹腔,这也与巨龙类相似。

与我国晚侏罗世的恐龙相比,江山龙的背椎椎体后宽与后高的比例(中部背椎)及椎体高度与椎弓高度的比例(后部背椎)和马门溪龙(*Mamenchisaurus*)较为相似,仅前者椎体侧视的相对长度显得略大(表1)。但从背椎的形态来看,江山龙与马门溪龙仍有所不同。马门溪龙的属型种合川马门溪龙中后部背椎椎体侧凹较小,椎弓上的坑凹及棱板构造也较不发育;其副突的位置较低,处于椎体上缘和前关节突连接面的中间,横突的位置也比较低,大致与前、后关节突连接面平齐(杨钟健、赵喜进,1972)。皮孝忠等(1996)曾报道在自贡新民的晚侏罗世地层中采集的马门溪龙一新种——*Mamenchisaurus youngi*(杨氏马门溪龙),其背椎神经棘棱板状构造的发育程度与江山龙接近,但其副突、横突的位置与合川种相似。

江山龙的最前部尾椎为微弱的前凹型,向后的尾椎椎体前凹后突渐不明显,这与国外的梁龙类及我国晚侏罗世的马门溪龙颇为相似。而江山龙的前凹型尾椎,保存的后部背椎和尾椎椎弓位于椎体的前上方(从椎体背面保留的痕迹及两侧尾肋近端附着的位置来看,其最前部尾椎的椎弓也应位于椎体的前上方),尾椎椎体侧凹不发育,这些与白垩纪繁盛的巨龙科的主要特征近似。

江山龙保存的尾椎神经棘后倾的角度较大,和椎体中轴方向约呈30°角,略大于较原始的蜥脚类 *Omeisaurus*,而与马门溪龙的合川种相当(何信禄等,1988)。

江山龙保存较完整的左侧肩胛骨和乌喙骨,其形态、大小与产自犹他州上白垩统North Horn组的蜥脚类阿拉蒙龙(*Alamosaurus* Gilmore,1922)相似:肩胛骨和乌喙骨粗壮;肩臼周缘较长,肩胛骨在肩臼的开口面向内侧倾斜,而乌喙骨的开口则面向外侧倾斜,其间的夹角略呈直角;肩胛骨的肩峰较为宽阔,前后的宽度约为肩胛骨骨干最小宽度的150%;大而平坦的上乌喙凹略呈卵圆形;乌喙孔位置近于乌喙骨的中央,与肩胛骨的接合缝距离较远(图1A)(Gilmore,1946;Lucas and Hunt,1989)。*Alamosaurus* 的第一尾椎双凸型,其余尾椎为较强烈的前凹型,椎弓位于椎体的前上部,无疑应归入白垩纪繁盛的巨龙科(Titanosauridae)(DeCourten,1998)。肩胛骨和乌喙骨在肩臼处开口面相对倾斜的特征,在晚侏罗世的盘足龙(*Euhelopus*)化石上也可以看到(Wilson and Sereno,1998)。

江山龙的耻、坐骨保存的远端与巨龙类相比较为粗大,骨干较直。耻骨远端宽厚,与较为原始的侏罗纪妖龙类(Cetiosaurids)特征相似;坐骨形态与合川马门溪龙的相似。

综上所述,从所保存的化石材料上看,江山龙可以确定如下的主要特征组合:1) 背椎椎弓坑凹、棱板构造发育,棱板边缘较薄;2) 后部背椎的椎体前突较为发育,呈半球状,椎

体腹面凹进明显;3) 保存的背肋具较为明显的凹沟;4) 肩胛骨的肩峰较为宽阔,其宽度约为肩胛骨骨干最小宽度的 150 %;5) 肩胛骨的肩臼面略向内侧倾斜,而乌喙骨的肩臼面向外侧倾斜;6) 大而平坦的上乌喙凹(scf)略呈卵圆形;7) 乌喙孔(cof)位置近于乌喙骨的中央,距与肩胛骨的接合缝较远;8) 肩臼开口呈直角或锐角;9)前部的尾椎为明显的前凹型椎体,椎弓着生于椎体的前部,保存的后部尾椎略呈双平型椎体,椎体侧凹不发育。

虽然江山龙还保留了部分晚侏罗世恐龙的原始特征,但其主要特征组合已显示出与白垩纪的恐龙更为相似。由于江山龙与白垩纪开始繁盛的巨龙科具有更多的共有特征,尤其肩带部分与产自犹他州上白垩统 North Horn 组的蜥脚类阿拉蒙龙(*Alamosaurus*)最为相近,所以本文将江山龙暂时归属巨龙科。

巨龙科以肩带粗壮、尾椎强烈前凹型、尾椎椎体无侧凹和椎弓位于椎体前上部为主要特征。巨龙科目前在印度、南美、欧洲和北美均有分布,保存均为头后骨骼,主要有 *Titanosaurus*、*Saltasaurus* 和 *Alamosaurus* 等,多数在晚白垩世地层中发现,中国境内以往还未见有报道。产自早白垩世晚期的江山龙也未保存头骨,所保存的尾椎、背椎和肩胛骨、乌喙骨的形态特征组合与已知的巨龙科各属的特征组合均不完全相同,考虑它们之间所存在的差异及地理分布的因素,在此将江山龙定为一新的属种。这是在我国首次记述的巨龙科的化石,为研究白垩纪蜥脚类恐龙在我国的演化分布提供了新的材料。

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A NEW SAUROPOD DINOSAUR OF CRETACEOUS FROM JIANGSHAN, ZHEJIANG PROVINCE

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Key words　Jiangshan, Zhejiang, Early Cretaceous, Titanosauridae, *Jiangshanosaurus*

Summary

The specimen described herein represents a new genus and species *Jiangshanosaurus lixianensis* of sauropod referable to the Titanosauridae. The specimen was collected by Wei Feng, Wu Wei-Tang and Kang Xi-Min in Jiangshan, Zhejiang allegedly from the lower part of Jinhua Formation in Albian (105Ma) horizon. The preserved part is fairly complete. Compared to the sauropod skeletons in China and other nations from Late Jurassic and Cretaceous, the diagnosis of scapulocoracoid and vertebrae of the new genus is most similar to those of Titanosauridae, especially *Alamosaurus*.

The new fossil is described as the Titanosauridae for the first time in China, and provides new material for studying the evolution and distribution of Cretaceous Sauropoda, Titanosauridae in China.

Saurischia Seeley, 1888
Sauropodomorpha Huene, 1932
Sauropoda Marsh, 1878
Titanosauridae Lydekker, 1885
Jiangshanosaurus **gen. nov.**

Type species *Jiangshanosaurus lixianensis* sp. nov. (Pls. I～II)

Etymology *Lixian, Jiangshan*, after the fossil-producing Lixian Village, Jiangshan County; *saurus* (Gr.), dinosaur.

Locality and horizon Lixian, Jiangshan County, Zhejiang Province; lower part of Jinhua Formation, late Early Cretaceous.

Holotype A relatively complete left scapulocoracoid, 5 posterior and mid-dorsal vertebrae, parts of both sides of pubis and ischium, 3 caudal vertebrae and parts of the femur shaft are preserved. Specimen number is M1322 in the Zhejiang Natural Museum.

Generic diagnosis As for genus. The concavity and lamina of dorsal neural spines are developed, and the margin of lamina is thin. The cranial convexity on the dorsal centra articular surface is strongly developed, with a nearly hemispherical articular ‘ball’, and the ventral surface is clearly concave. The preserved dorsal ribs appear distinct pneumatization. The acromial process of scapula has large proximal expansion and the width is about 150 percent of minimum width of the blade. The scapular glenoid faces medially whereas the coracoid glenoid faces laterally. The large and flat supracoracoideus fossa is oval-shaped. The coracoid foramen is situated nearly at the center of coracoid and far from the suture connecting the scapula. The scapular glenoid opens with right angle. Articulations between the cranial caudal centra are distinct procoelous, and the preserved middle caudal centra are mildly procoelous. Neural arches of caudals are situated on the cranial half of the centrum. Pleurocoels in caudal centra are absent.

Description The left scapulocoracoid is well preserved, only distal blade is absent, and the proximal end articulates with the coracoid in which the preserved length is about 87cm. The preserved shaft is 46cm in length, about 18cm in median breadth. The proximal end distinctly expanded and the breadth is 62cm, and the suture part is approximately 32cm in length. The thickest of shaft is situated at posterior margin of the axis, which is relatively blunter than anterior one that gets thin into blade-shaped. The expanding part of proximal end clearly thickened on both parts of the glenoid and the ridge of supracoracoideus fossa, which is relatively large and flat, oval-shaped in outline. The glenoid between the scapula and coracoid opens largely, approximately 30cm in length. The acromial process protrudes gently to the shaft at obtuse angle (Fig. 1A; P1. I, 1).

The preserved left coracoid is fairly large, about 33cm in length and 46cm in breadth. It shows flat, round-shaped, and is equal to scf. of proximal end of the scapular in size. The cof. is relatively small, almost situated at the center, relatively far from the suture connecting the scapula, ellipse-shaped in outline, with the long axis 4.8cm and short one 3.6 cm in length. The coracoid glenoid is about 16cm in length and faces laterally whereas the scapular glenoid faces medially (Fig. 1A; P1. I, 1).

The pubis is flat plate-shaped. Middle and distal portion of pubis forms a transverse sheet of bone which conjecturally lies in approximately the same plane as the proximal end. The preserved left pubis is about 76cm in length and the distal end is about 33cm in breadth. The preserved right pubis 68cm in length and the distal end 31cm in breadth. The connecting surface between distal ends of both left and right pubis inwards twisted into lip-shaped, and it is rough and crimpy and the transverse breadth is about 5 to 7cm (Fig. 2A).

The preserved ischia are fragmentary and flat. Anterior margin is relatively thin and the posterior blunt. Distal end is relatively complete and only slightly expanded relative to the

rest of the shaft. The left ischium is 71cm in length and the distal end about 14cm in breadth;the median shaft is 11cm in minimum breadth. The portion of the proximal end expanded toward posterior margin is absent, and the reconstructed proximal end is about 32cm in breadth and the surface connecting the pubis is relatively blunt and thick. The connecting surfaces of distal ends of both left and right ischia have relatively rounded rugosity and expand transversely to 6cm. The preserved right ischium is 52cm in length, and the distal end 16cm in breadth and the shaft is 12.6cm in minimum breadth. The proximal end is not strongly expanded and gently transited into the distal shaft (Fig. 2B).

The preserved part of femur referable to middle shaft is 84cm in length and 25cm in minimum breadth. Both proximal and distal ends are absent. Cross-sectional shape of the shaft is elliptical, with long axis oriented mediolaterally. The position of the 4th trochanter emerged on the shaft cannot be judged.

Five middle-rear dorsal vertebras are preserved in the specimen, of which, three ones articulate each other, and the centra are completely preserved while the neural spines are fragmentary. Both prezygapophysis and postzygapophysis of the three centra touched closely. The height of neural spines is slightly greater than height of posterior centrum face. The tops of neural spines are slightly expanded, flat and single-shaped. The preserved laminas are developed but the original form is not very clear for compression and fragment. The height of the stout centrum is about three-fifths of the neural arches The pleurocoels in dorsal centra are large, deep with the long axis 5.5 to 7.8cm in length and have rounded cranial margins but tapering, acute caudal margins. They are situated at upper side close to hemispherical ball. The three articulated dorsal vertebra could be assigned to be 9th, 10th and 11th by measurement and comparison.

Three incomplete caudal vertebrae are preserved. One centrum of them is short and stout, slightly procoelous. The centrum is about 22.7cm in width in anterior view and 11.6cm in thickness in ventral view. The caudal is assessed to be first one by size. The preserved proximal ends of caudal ribs with ear-shaped are expanded toward upper part of the centrum. The neural arch is situated on cranial half of the centrum and the chevron surface cannot be seen at the ventral surface of the centrum. The other two caudals are similar in size and form, and maybe the median caudals. One of the two neural spines is well preserved, flat stick-shaped, and has the slightly expanded end. It is about 5.8cm in breadth and 17.5cm in height that is 1.4 times as that of the centrum in lateral view. The angle inclining backward is fairly large and about 65° with the central axis, and it is somewhat larger than that of *Omeisaurus* and similar to *Mamenchisaurus hechuanensis*. Both prezygapophysis and post-zygapophysis are well developed, and the expanding width of the prezygapophysis is equal to width of the neural spine. The upper margin of postzygapophysis extended and is near to the median part of the neural arch, and the posterior margin is parallel to the surface of posterior extremity of centrum. The caudal ribs are absent and only lateral processes appear on both upper sides of the centrum. The centrum is massive and procoelous while the posterior processes are not distinct. It is about 10cm in length and 12cm in height in lateral view, and 9cm in anterior width. The neural canal of upper margin is about 1.7cm in diameter. Another neural arch is incomplete but the articulation faces are not strongly procoelous. The lateral processes are not seen on both sides, a ridge is remained on upper-side and maybe the vestige of lateral process. Procoelous centrum of *Ma. hechuanensis* changes gradually into amphiplatyan since 15th caudal, and the lateral process developed on cranial caudal smaller backward and totally absent until the 16th caudal (Young and Chao, 1972). An elongated ridge is emerged on both sides after 15th caudal of *Omeisaurus* and the ridges are absent until the 31st caudal (He et al., 1988). By comparison, the former caudal of the sauropod from Jiang-shan is assigned 13th or 14th caudal and the latter is 16th or 17th caudal.

Comparison and discussion It has so far known that the sauropods of Early Cretaceous discovered in China are not common and incompletely preserved and have fairly less species, including *Asiatosaurus* cf. *A. mongoliensis* (Dong, 1973) excavated from Wuerho, Xinjiang, *Asiatosaurus kwangshiensis* (Hou et al., 1975) from Fusui, Guangxi and *Nuoersaurus chaganensis* (Dong, 1992) from Erohot, Nei Mongol.

The sauropod described here from the lower part of Jinhua Formation of Early Cretaceous in Jiangshan, Zhejiang is different from the specimens mentioned above.

The middle and caudal dorsal vertebras of *Jiangshanosaurus lixianensis* are comparable to that of Diplodocoids and Titanosaurids. They are all characterized by, for example, developed concavity and lamina on neural arch, deep pleurocoel on both sides of dorsal centrum, strongly convex on the cranial surface of the centrum. Both the proportions of posterior width to posterior height (median d.v.) and of height of centrum to that of neural arch is fairly similar to those of Late Jurassic sauropods in China, *Mamenchisaurus*, but the relative length of centrum of the former in lateral view is larger (Table 1). From the form of d.v., the specimen from Jiangshan differs greatly from *Ma. hechuanensis*. The pleurocoel of centrum of d.v. of *Ma. hechuanensis* is small and the neural arch fossa and lamination adhering to muscle are not well developed. The parapophysis of *Ma. hechuanensis* is situated lowly at the center of connecting surface between the upper margin of centrum and the prezygapophysis, and the position of transverse process is roughly parallel to the surface. The pleurocoel and cranial process of centrum, and neural arch fossa of the sauropod from Jiangshan are relatively developed.

The neural arch of *Diplodocus* dorsal is relatively high, and the height of centrum is smaller than that of neural spine, and the cranial process is slightly developed. No parapophysis is developed on either *Brachiosaurus* or *Titanosaurus*. And the pneumatic dorsal rib of sauropod from Jiangshan is similar to that of titanosaurs.

Procoelous articulations between the cranial caudal centra, neural arches of caudal vertebras on the cranial half of the centrum and pleurocoels absent in caudal centra also characterize the new genus to be as titanosaurs.

The completely preserved scapulocoracoid of the sauropod from Jiangshan is similar in both form and size to *Alamosaurus* (Giomore, 1922) of North Horn Formation of Early Cretaceous from Utah, U.S. The acromial ridge on lateral surface of the scapular proximal expansion is absent. The breadth between dorsal and ventral margins is about 150 per cent of minimum breadth of the scapular shaft. The large and flat supracoracoideus fossa appears oval. The coracoid foramen is situated nearly at the center of coracoid and far from the crevice connecting the scapula. The glenoid opens with right angle. The scapular and coracoid glenoid are offset with respect to each other. *Alamosaurus* is assigned to be Titanosauridae (Giomore, 1946) by the characteristics of procoelous caudal vertebrae, cranial half position of caudal neural arch on the centrum, etc.

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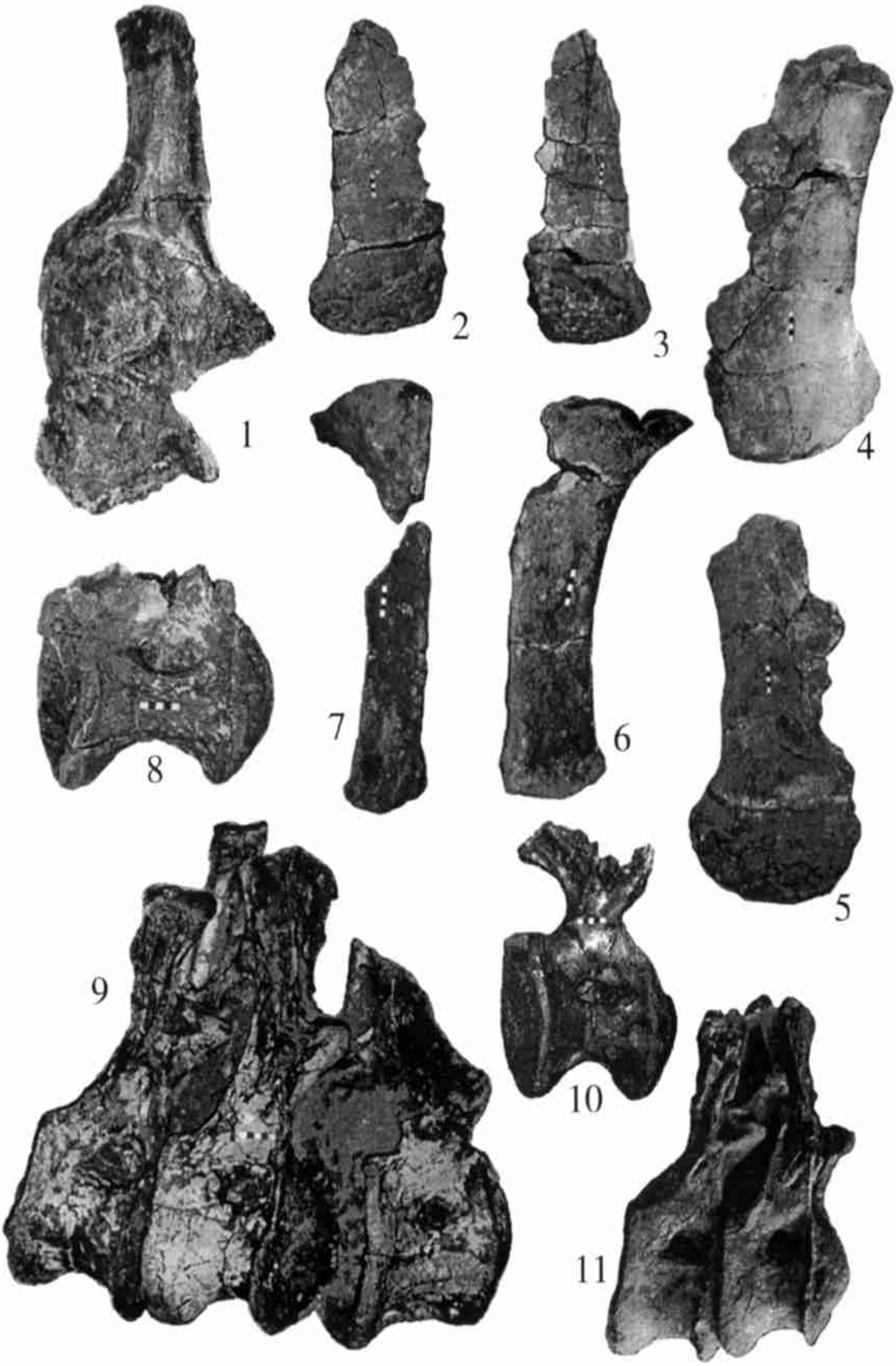
图版说明(Explanations of plates)

图版 I (Plate I)

礼贤江山龙(新属新种) (*Jiangshanosaurus lixianensis* gen. et sp. nov.) ,M 1322,scale = 5cm 1. **左肩胛骨、乌喙骨的外侧视**(Left scapulocoracoid in lateral view);2～3. **左耻骨的外、内侧视**(Left pubis in lateral and medial views);4～5. **右耻骨的外、内侧视**(Right pubis in lateral and medial views);6～7. **左、右坐骨的内侧视**(Left and right ischia in medial view); 8. **第7背椎右侧视**(Right side of 7th dorsal vertebra);9. **第9、10、11背椎侧视**(9th,10th,11th dorsal vertebra in lateral view);10. **第9背椎侧视**(9th dorsal vertebra in lateral view);11. **第10、11背椎右侧视**(Right side of 10th,11th dorsal vertebra)

图版 II (Plate II)

礼贤江山龙(新属新种) (*Jiangshanosaurus lixianensis* gen. et sp. nov.) ,M 1322,scale = 5cm 1～2. **第1尾椎的前视、腹视**(1st caudal vertebra in anterior and ventral view);3,4,6,8. **第13或14尾椎的前、顶视和侧视及后视**(13th or 14th caudal vertebra in anterior,posterior, lateral and dorsal views);5,7. **第7背椎前视、腹视**(7th dorsal vertebra in anterior and ventral views);9～11. **第16或17尾椎的后视、前视、侧视**(16th or 17th caudal vertebra in posterior,anterior and lateral views)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